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Baik

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[54] **THREE TUBE BEAM PROJECTION SYSTEM AND METHOD**

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[21] Appl. No.: **357,170**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.**[6] **H04N 5/74**; H04N 9/31

[52] **U.S. Cl.** **348/744**; 348/779; 348/825; 348/836

[58] **Field of Search** 348/744, 745, 348/776, 778–779, 781–782, 825, 836; 358/60, 231; 313/2.1; H04N 5/74, 9/31

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,194,216 3/1980 Ohmori 348/781

4,473,840 9/1984 Miyatake 348/745

5,276,524 1/1994 Inoue et al. 348/778

Primary Examiner—Sherrie Hsia

[57] **ABSTRACT**

A projection system suitable for reducing the convergence angles for red, green and blue color beams is disclosed. The projection system includes first and second beam projection tubes arranged in an in-line type arrangement in the center of the interior of a support part of the system, and a third beam projection tube placed beside the first and second beam projection tubes and inclined relative to the first and second projection tubes at predetermined inclination angles. A dichroic mirror is placed on an optical axis of the third projection tube in front of the third projection tube. The dichroic mirror transmits the beams projected by the first and second projection tubes but reflects the beam projected by the third projection tube. The third beam projection tube may be placed in back of the first and second beam projection tubes.

18 Claims, 10 Drawing Sheets

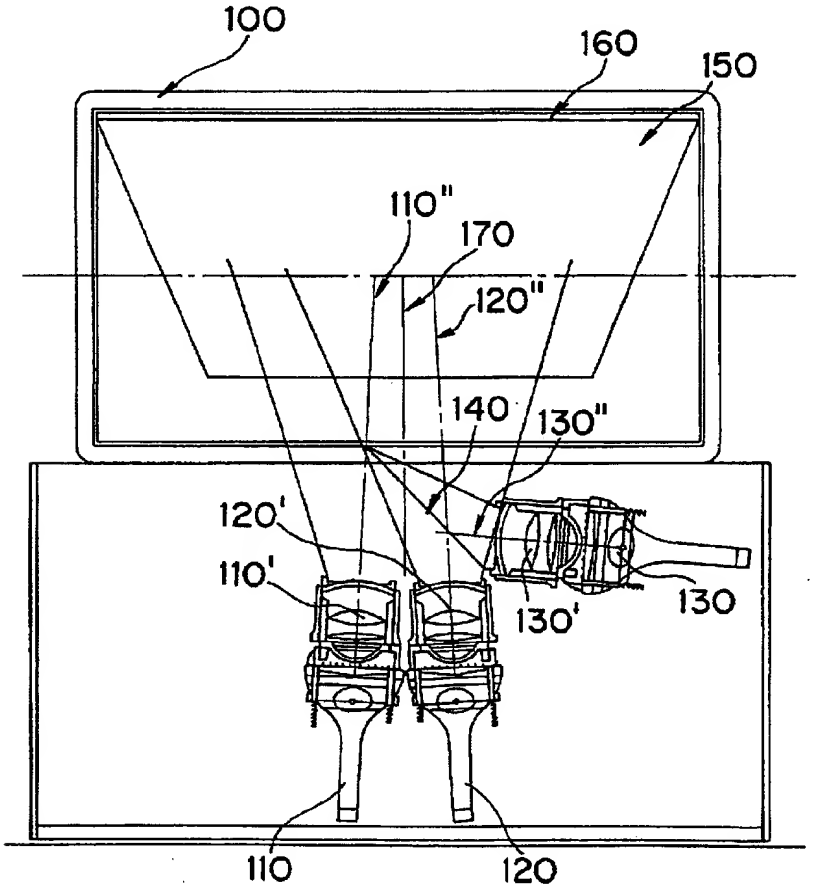


FIG. 1
CONVENTIONAL ART

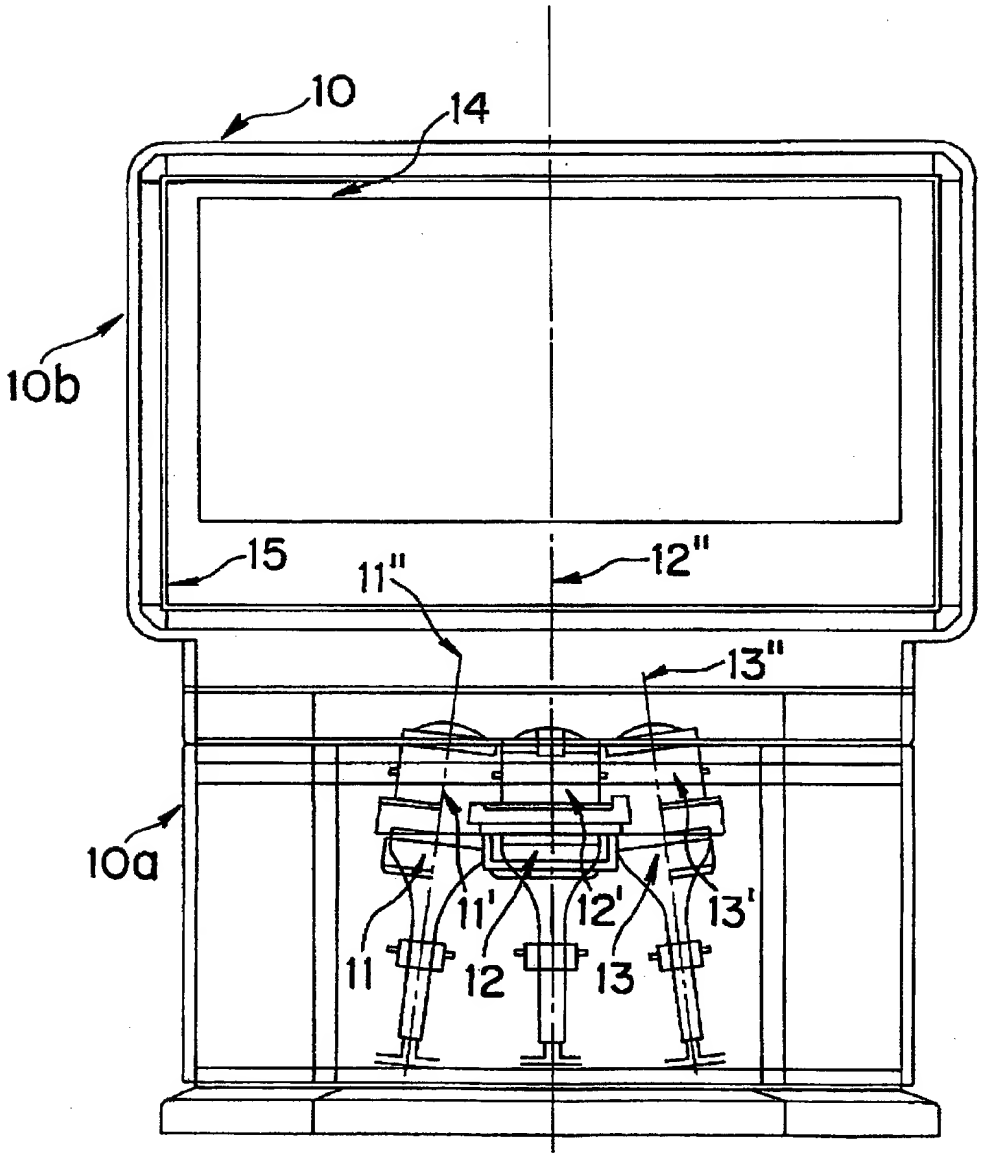


FIG. 2
CONVENTIONAL ART

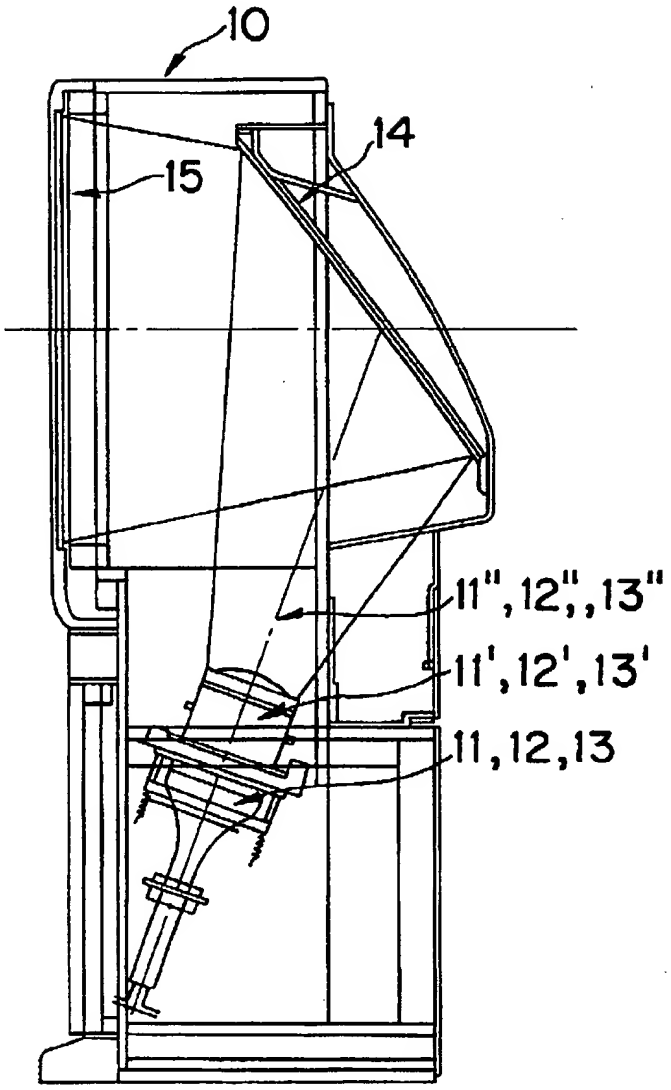


FIG. 3
CONVENTIONAL ART

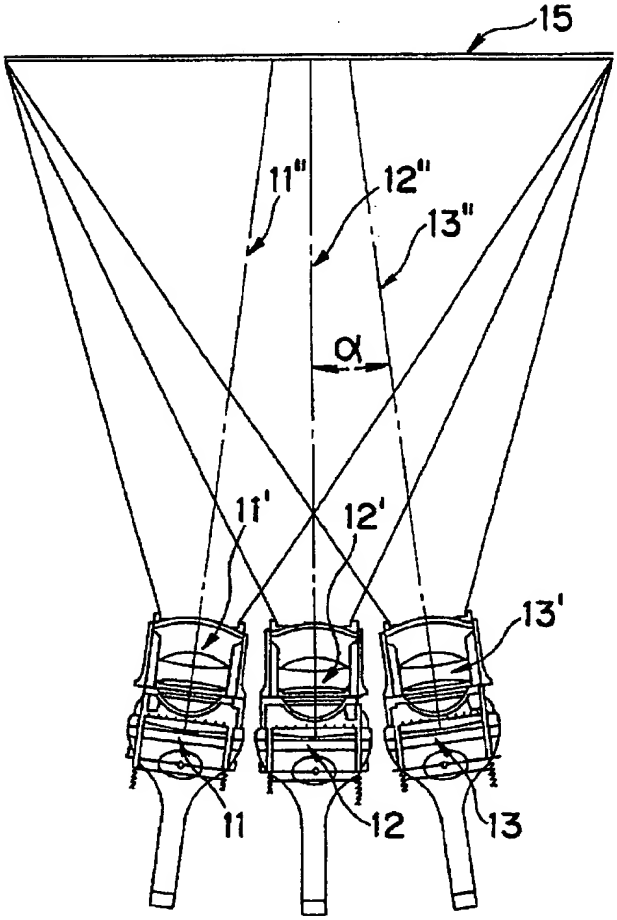


FIG. 4
CONVENTIONAL ART

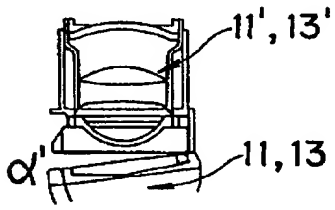


FIG. 5

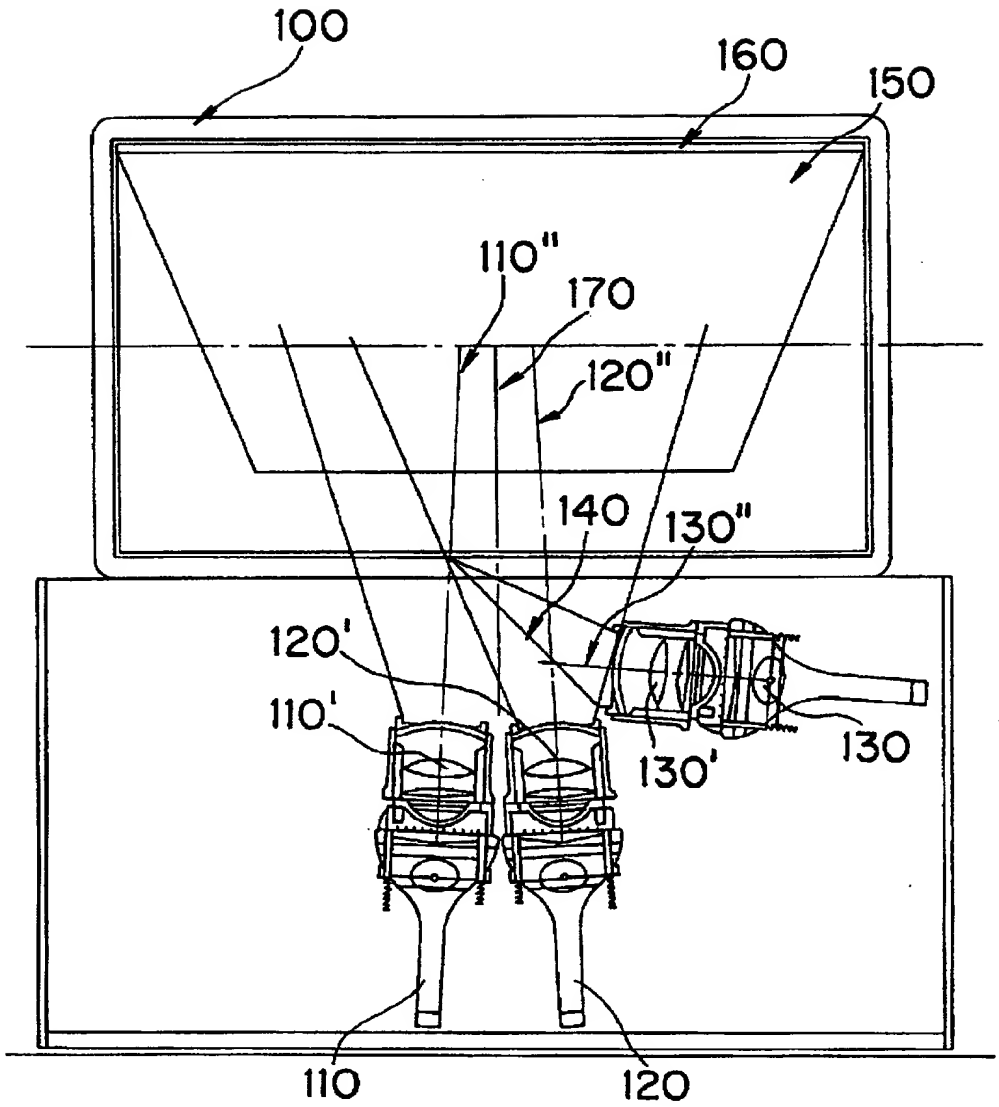


FIG. 6

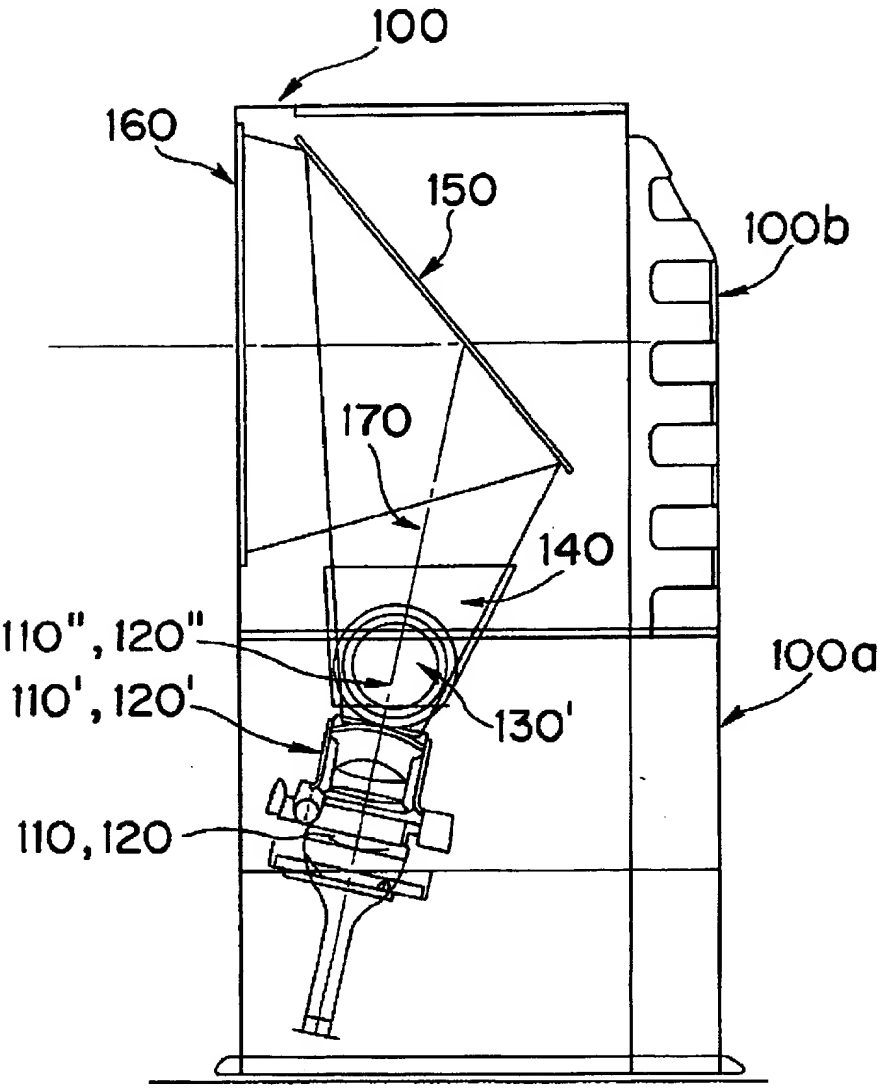


FIG. 7

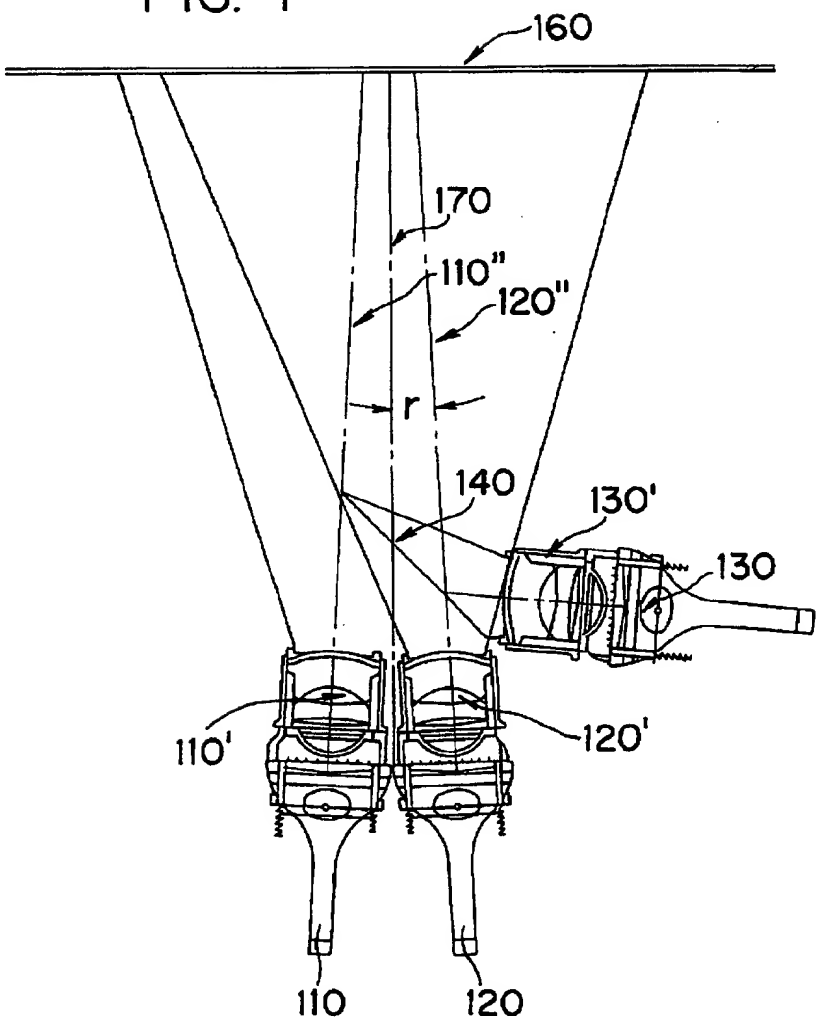


FIG. 8

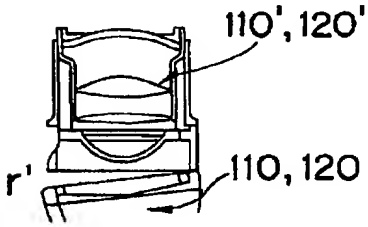


FIG. 9

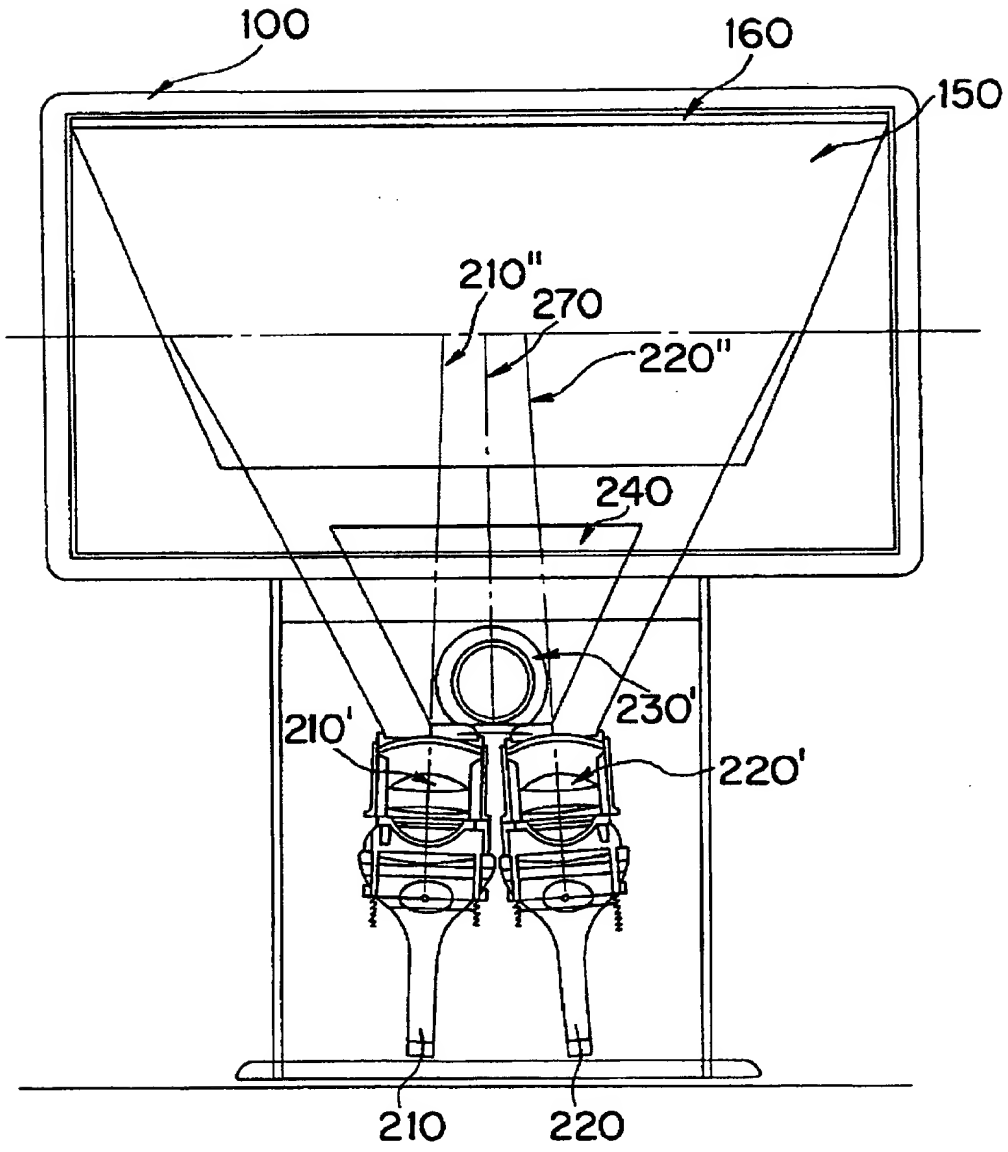


FIG. 10

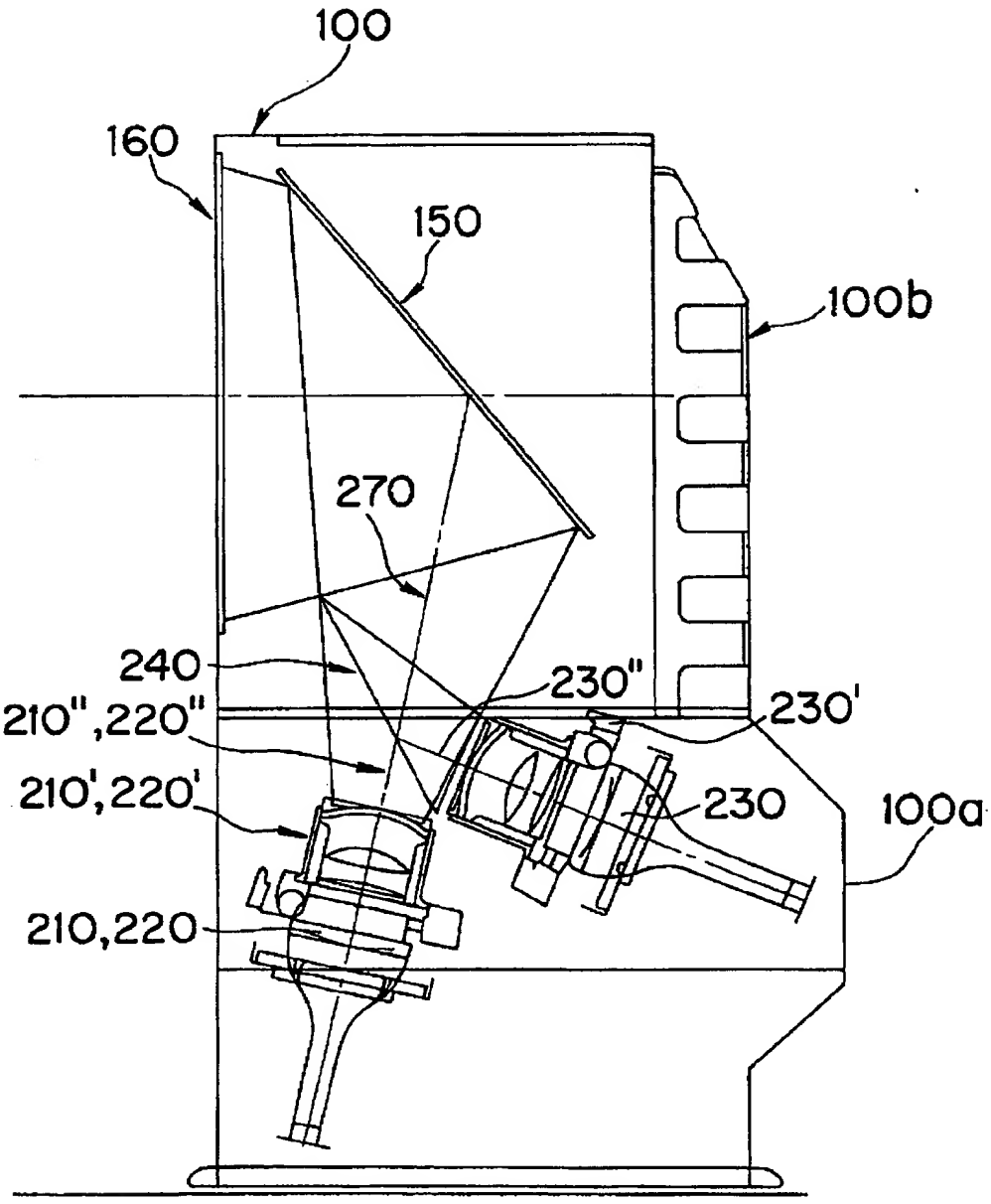

100
160
150
100b
270
240
230"
210",220"
230'
210',220'
230
100a
210,220

FIG. 11

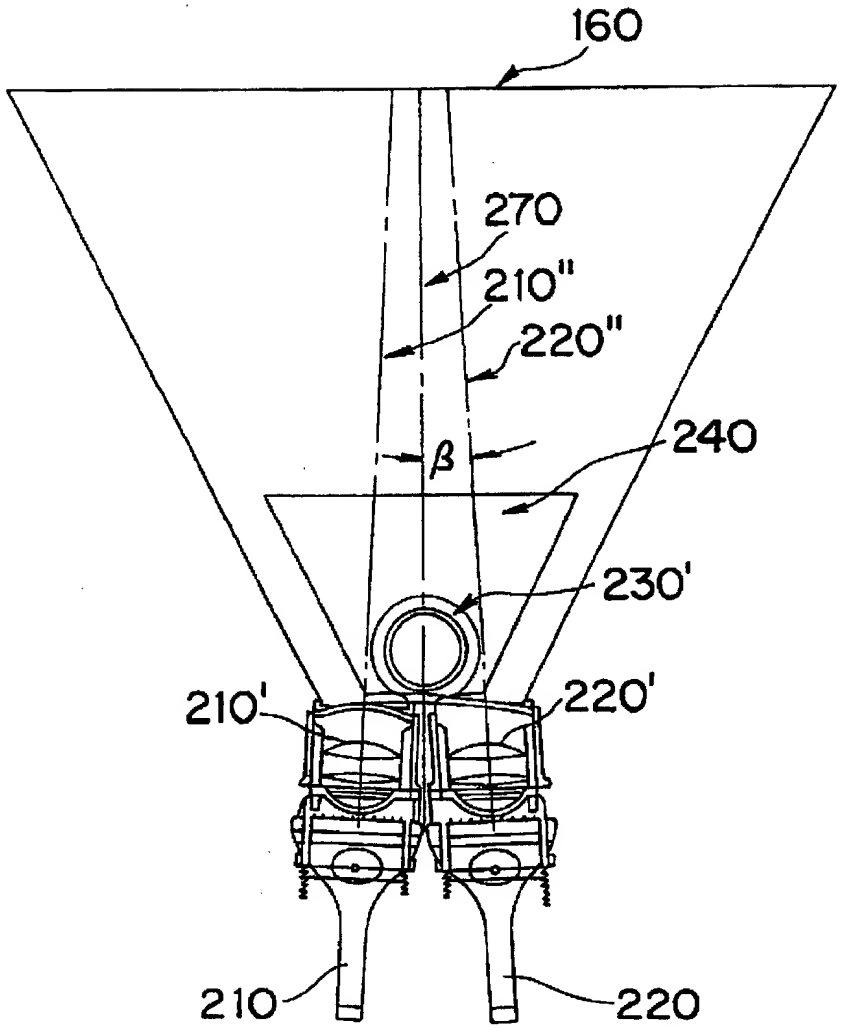


FIG. 12

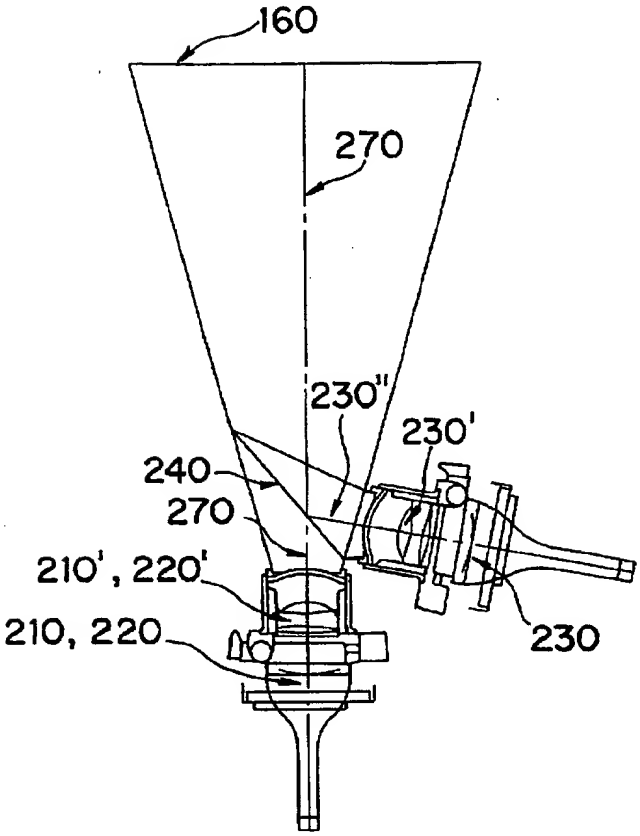
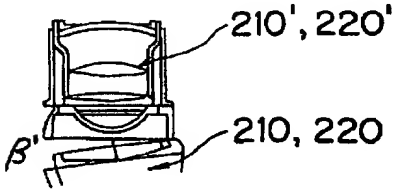


FIG. 13



THREE TUBE BEAM PROJECTION SYSTEM AND METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates in general to a projection system and, more particularly, to a structural improvement in such a projection system for reducing the convergence angles for red, green and blue color beams using a dichroic mirror, thus to increase the horizontal and vertical visible angles, reduce color shift of a color picture displayed on a screen, improve uniformity of the color picture, reduce convergence compensating amount, as well as circuit compensating amount or keystone compensating amount and to improve luminance due to reduction of the keystone compensating amount.

2. Description of the Background Art

With reference to FIGS. **1** to **4**, there is shown a typical projection system. As shown in these drawings, the typical projection system **10** has a support part **10***a* and a screen part **10***b* in its bottom section and in its top section respectively.

In the interior of the support part **10***a*, three beam projection tubes, that is, a red beam projection tube **11** having a first projection lens **11'** in its front section, a green beam projection tube **12** having a second projection lens **12'** in its front section and a blue beam projection tube **13** having a third projection lens **13'** in its front section, are arranged in a horizontal line in the center of the interior of the support part **10***a*, thus to form an in-line arrangement of the beam projection tubes. In the above projection system, the red beam projection tube **11**, the green beam projection tube **12** and the blue beam projection tube **13** have a first side optical axis **11"**, a center optical axis **12"** and a second side optical axis **13"**, respectively.

Placed in the screen part **10***b* above the three beam tubes **11**, **12** and **13** is a reflection mirror **14** that reflects the beams of the three optical axes **11"**, **12"** and **13"**. A screen **15** is placed in front of the reflection mirror **14**, so that the screen **15** displays thereon the three beams reflected by the reflection mirror **14**.

The first and second side optical axes **11"** and **13"** are inclined at an angle α of inclination relative to the center optical axis **12"** as shown in FIG. **3**. The inclination angle α is so-called a convergence angle of the projection system **10**. In order to compensate for the deviation of the three beams caused by the convergence angle α, each of first and second projection tubes **11** and **13** of the projection system **10** is provided with Scheimflug angle α' as shown in FIG. **4**.

As the red beam tube **11**, the green beam tube **12** and the blue beam tube **13** are arranged in the in-line type as described above, the first and second side optical axes **11"** and **13"** of the red and blue beam projection tubes **11** and **13** should be deflected toward the center optical axis **12"** of the green beam projection tube **12** at a predetermined angle. However, the deflection of the first and second side optical axes **11"** and **13"** increases compensating amount, thus causing a difficulty in compensation. Even when the color picture is fortunately accurately focused on the screen **15** as a result of compensation, there may be another problem of color shift in the color picture displayed on the screen **15**. A further problem of the typical projection system is resided in that the system not only narrows the vertical and horizontal visible angles but also causes nonuniform color of the picture displayed on the screen **15**.

In addition, when using a short focus lens in order to reduce the length of the beam path, the total conjugation length (TCL) is shortened, thus increasing the compensating amount due to the intervals between the three beam projection tubes **11**, **12** and **13**, increasing color shift of the picture displayed on the screen **15**, and increasing convergence compensating amount as well as keystone compensating amount. Both increases in the convergence compensating amount and in the keystone compensating amount cause a circuit to be overloaded. Particularly, the increase in the convergence compensating amount causes deterioration of both luminance and resolution of the picture displayed on the screen.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a projection system in which the above problems can be overcome and which reduces the convergence angles for red, green and blue color beams using a dichroic mirror, thus to increase the horizontal and vertical visible angles, reduce color shift of a color picture displayed on a screen, improve uniformity of the color picture, reduce convergence compensating amount as well as keystone compensating amount of a circuit, and to improve luminance of the color picture due to reduction of the keystone compensating amount.

In order to accomplish the above object, a projection system in accordance with a preferred embodiment of the present invention comprises: a support part and a screen part provided in a bottom section and in a top section of the projection system; first and second beam projection tubes arranged in the in-line type in the center of the interior of the support part; a third beam projection tube placed beside the first and second beam projection tubes, the third projection tube being arranged in the in-line type relative to the first and second projection tubes but inclined relative to the first and second projection tubes at predetermined inclination angles; and a dichroic mirror placed on an optical axis of the third projection tube in front of the third projection tube, the dichroic mirror transmitting the beams projected by the first and second projection tubes but reflecting the beam projected by the third projection tube.

In accordance with another embodiment of the invention, the third beam projection tube is placed in back of the first and second beam projection tubes and inclined relative to the first and second projection tubes at predetermined inclination angles.

Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a front view of a typical projection system;

FIG. **2** is a side view of the projection system of FIG. **1**;

FIG. **3** is a front view of the projection system of FIG. **1**, showing optical paths of three projection tubes of the typical projection system;

FIG. 4 is a view of a beam projection tube of the projection system of FIG. 1, showing Scheimflug angle of the typical projection system;

FIG. 5 is a front view of a projection system in accordance with a first embodiment of the present invention;

FIG. 6 is a side view of the projection system of FIG. 5;

FIG 7 is a front view of the projection system of FIG. 5, showing optical paths of projection tubes of the projection system;

FIG. 8 is a view of a beam projection tube of the projection system of FIG. 5, showing Scheimflug angle of the projection system;

FIG. 9 is a front view of a projection system in accordance with a second embodiment of the present invention;

FIG. 10 is a side view of the projection system of FIG. 9;

FIG. 11 is a front view of the projection system of FIG. 9, showing optical paths of projection tubes of the projection system;

FIG. 12 is a side view of the projection system of FIG. 9, showing the optical paths of the projection tubes of the projection system; and

FIG. 13 is a view of a beam projection tube of the projection system of FIG. 9, showing Scheimflug angle of the projection system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIGS. 5 to 8, there is shown a projection system in accordance with a first embodiment of the present invention. As shown in these drawings, the projection system **100** has a support part **100***a* and a screen part **100***b* in its bottom section and in its top section, respectively.

In the interior of the support part **100***a*, a first beam projection tube **110** having a first projection lens **110'** in its front section and a second beam projection tube **120** having a second projection lens **120'** in its front section are arranged in the in-line type arrangement in the center of the interior of the support part **100***a*, thus to form an in-line arrangement of the beam projection tubes **110** and **120**. The first and second beam projection tubes **110** and **120** have their center optical axes, that is, first and second center optical axes **110"** and **120"**, which center a third center optical axis **170**. Adjacent to the first and second projection tubes **110** and **120**, a third beam projection tube **130** having a third projection lens **130'** in its front section is placed such that the third projection tube **130** is arranged in the in-line type arrangement relative to the first and second projection tubes **110** and **120**, but inclined relative to the first and second projection tubes **110** and **120** at predetermined inclination angles. The third projection tube **130** having the third projection lens **130'** has a side optical axis **130"**. Placed on the side optical axis **130"** in front of the third projection lens **130** is a dichroic mirror **140** which is inclined relative to the side optical axis **130"** at a predetermined inclination angle. The dichroic mirror **140** transmits the beams projected by the first and second projection tubes **110** and **120** but reflects the beam projected by the third projection tube **130**.

The optical axis **130"** of the beam projected by the third projection tube **130** and reflected by the dichroic mirror **140**, coincides with the third center optical axis **170** at a predetermined position.

The beams of the first to third center optical axes **110"**, **120"** and **170**, after being transmitted through the dichroic mirror **140**, are reflected by a reflection mirror **150** and in turn displayed on a screen **160** of the screen part **100***b*.

In order to converge the first and second center optical axes **110"** and **120"** into the third center optical axis **170**, the first and second beam projection tubes **110** and **120** are inclined relative to the third center optical axis **170** at a convergence angle γ as shown in FIG. **7**. In order to compensate for the deviation of the three beams caused by the convergence angle γ, each of the first and second projection tubes **110** and **120** of the projection system **100** is also provided with Scheimflug angle γ' as shown in FIG. **8**.

In the projection system of the first embodiment, the dichroic mirror **140** is specifically constructed in such a manner that the mirror **140** is coated with a filter so as to reflects the beam projected by the third projection tube **130** but transmit the beams projected by the first and second projection tubes **110** and **120**.

When letting the third projection tube **130** be a blue beam projection tube, the dichroic mirror **140** will be coated with a short wavelength beam transmissive filter. However, when letting the third projection tube **130** be a green beam projection tube, the dichroic mirror **140** will be coated with a specified wavelength beam transmissive filter.

Turning to FIGS. **9** to **13**, there is shown a projection system in accordance with a second embodiment of the present invention. In the second embodiment, the general shape of the projection system remains the same as described for the projection system of the first embodiment, but the position of the third projection tube as well as the position of the dichroic mirror is alternated. That is, the third projection tube **230** of the projection system of the second embodiment is placed in a predetermined position in back of first and second projection tubes **210** and **220**. Otherwise stated, the third projection tube **230** is placed in the predetermined position in the rear section of the projection system **100**.

In the projection system of the second embodiment, the dichroic mirror **240** is placed on a side optical axis **230"** of the third projection tube **230** in front of the third projection lens **230**. The dichroic mirror **240** is inclined relative to the optical axis **230"** at a predetermined inclination angle. The dichroic mirror **240** transmits the beams projected by first and second projection lenses **210'** and **220'** of the first and second projection tubes **210** and **220** but reflects the beam projected by a third projection lens **230'** of the third projection tube **230** as described for the first embodiment.

The optical axis **230"** of the beam projected by the third projection lens **230'** and reflected by the dichroic mirror **240**, coincides with a third center optical axis **270** formed by first and second center optical axes **210"** and **220"** of the first and second projection tubes **210** and **220**.

The beams of the first to third center optical axes **210"**, **220"** and **270**, after being transmitted through the dichroic mirror **240**, are reflected by the reflection mirror **150** and in turn displayed on the screen **160** of the screen part **100***b*.

In order to converge the first and second center optical axes **210"** and **220"** into the third center optical axis **270**, the first and second beam projection tubes **210** and **220** are inclined relative to the third center optical axis **270** at a convergence angle β as shown in FIG. **11**. In order to compensate for the deviation of the three beams caused by the convergence angle β, each of the first and second projection tubes **210** and **220** of the second embodiment is also provided with Scheimflug angle β' as shown in FIG. **13**.

The projection system of the second embodiment yields the same operational effect as described for the first embodiment. Therefore, a further explanation for the operational effect of the second embodiment will not be necessary.

As described above, the projection system of the present invention reduces optical compensating amount as well as circuit compensating amount during a beam projection of a three tube/three lens projection system. Therefore, this projection system results in improvement of picture quality, reduction of color shift of the picture displayed on the screen and uniformity of color of the picture. The projection system also increases vertical and horizontal visible angles, enlarging the visible region of the screen. Additionally, reduction of the circuit compensating amount results in precise compensation for convergence, and reduction of keystone compensating amount results in improvement of luminance of the picture.

The projection system of the invention may be preferably adapted to a forward projection system with television using three tubes and three lenses, adapted to a backward projection system with television using three tubes and three lenses, and a multi-projection system with television using three tubes and three lenses.

Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

What is claimed is:

1. A projection system having a support part in a bottom section of the system and a screen part in a top section of the system, the system comprising:

first and second beam projection tubes arranged in-line in a center of an interior of the support part, wherein said first beam projection tube is beside said second beam projection tube;

a third beam projection tube placed beside said first and second beam projection tubes, said third beam projection tube being arranged substantially coplanar with the first and second beam projection tubes and being inclined relative to the first and second beam projection tubes at predetermined inclination angles; and

partially reflecting means, placed on an optical axis of said third beam projection tube in front of the third beam projection tube, for transmitting beams projected by the first and second beam projection tubes and reflecting a beam projected by the third beam projection tube.

2. The projection system according to claim 1, wherein optical axes of the first and second beam projection tubes coincide with the optical axis of the third beam projection tube at a predetermined position.

3. A projection system having a support part in a bottom section of the system and a screen part in a top section of the system, the system comprising:

first and second beam projection tubes arranged in-line in a center of an interior of the support part;

a third beam projection tube placed in back of and between said first and second beam projection tubes, said third beam projection tube being inclined relative to the first and second beam projection tubes at predetermined inclination angles; and

partially reflecting means, placed on an optical axis of said third beam projection tube in front of the third beam projection tube, for transmitting beams projected by the first and second beam projection tubes and reflecting a beam projected by the third beam projection tube.

4. The projection system according to claim 3, wherein optical axes of the first and second beam projection tubes coincide with the optical axis of the third beam projection tube at a predetermined position.

5. A projection system according to claim 1, wherein each of said first and second beam projection tubes is provided with Scheimflug angle.

6. A projection system according to claim 1, further comprising:

a screen disposed in the screen part, and

reflection means, disposed in the screen part, for reflecting onto said screen the beams transmitted through and the beam reflected by said partially reflecting means.

7. A projection system according to claim 6, wherein said reflection means includes a reflection mirror.

8. A projection system according to claim 1, wherein each of said first, second, and third beam projection tubes includes a projection lens.

9. A projection system according to claim 1, wherein said partially reflecting means includes a dichroic mirror.

10. The projection system according to claim 3, wherein each of said first and second beam projection tubes is provided with Scheimflug angle.

11. The projection system according to claim 3, further comprising:

a screen disposed in the screen part, and

reflection means, disposed in the screen part, for reflecting onto said screen the beams transmitted through and the beam reflected by said partially reflecting means.

12. The projection system according to claim 11, wherein said reflection means includes a reflection mirror.

13. A projection system according to claim 3, wherein each of said first, second, and third beam projection tubes includes a projection lens.

14. A projection system according to claim 3, wherein said partially reflecting means includes a dichroic mirror.

15. A method of projecting light beams onto a screen of a projection system, comprising the steps:

providing first and second beam projection tubes beside each other and arranged in-line in an interior of a support part of the projection system;

placing a third beam projection tube beside the first and second beam projection tubes so that the third beam projection tube is substantially coplanar with the first and second beam projection tubes and inclined relative to the first and second beam projection tubes at predetermined inclination angles;

transmitting beams projected by the first and second beam projection tubes and reflecting a beam projected by the third beam projection tube; and

reflecting the transmitted and reflected beams onto the screen.

16. A method according to claim 15, wherein said transmitting and reflecting steps include the step of using a dichroic mirror placed on an optical axis of the third beam projection tube in front of the third beam projection tube and using a reflection mirror.

17. A method of projecting light beams onto a screen of a projection system, comprising the steps:

providing first and second beam projection tubes arranged in-line in an interior of a support part of the projection system;

placing a third beam projection tube in back of and between the first and second beam projection tubes, the third beam projection tube being inclined relative to the first and second beam projection tubes at predetermined inclination angles;

transmitting beams projected by the first and second beam projection tubes and reflecting a beam projected by the third beam projection tube; and

reflecting the transmitted and reflected beams onto the screen.

18. A method according to claim 17, wherein said transmitting and reflecting steps include the step of using a dichroic mirror placed on an optical axis of the third beam projection tube in front of the third beam projection tube and using a reflection mirror.

* * * * *